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ट्रेलरों के लिए प्राइम मूवरों के चयन — मार्गदर्शिका

Indian Standard

SELECTION OF PRIME MOVERS FOR TRAILERS — GUIDELINES

ICS 43.080.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 2005

Price Group 2

Transport Tractors, Trailers and Industrial Trucks Sectional Committee, TED 22

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Transport Tractors, Trailers and Industrial Trucks Sectional Committee had been approved by the Transport Engineering Division Council.

The prime mover, that is, tractor is selected primarily on the basis of total draw bar pull requirements.

In this standard SI units have been used, the unit of force in Newton (N), of tyre load in kilogram (kg) and of pressure in pascal (Pa). Their relationships are given below for information:

1 kgf = 9.806 65 N (exactly)
= 9.81 N (approx)
= 10 N (within 2 percent error)
1 kPa = 0.01 kgf/cm^2 (within 2 percent error)
1 kgf/cm^2 = 98.066 kPa.

NOTE — Values of 1 kPa rounded to the nearest practical unit.

The composition of the Committee responsible for formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SELECTION OF PRIME MOVERS FOR TRAILERS — GUIDELINES

1 SCOPE

1.1 This standard lays down procedure for selection of prime movers for semi-trailers.

1.2 The procedure given in this standard can also be used for full trailers with the deletion of fifth wheel loading.

2 REFERENCE

The following standard contains provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

IS No.	*Title*
11852 (Part 9) : 2003	Automotive vehicles — Brakes and braking systems: Part 9 Requirements for vehicles equipped with anti-lock braking systems

3 NOTATIONS USED

Following notations have been used in this standard:

a) Tractor unladen weight, kgf $= W_1$
b) Fifth wheel loading, kgf $= W_2$
c) GVW of tractor, kgf $= W_1 + W_2 = W_3$
d) GVW of trailer, kgf $= W_4$
e) Towed weight of trailer, kgf $= W_4 - W_2 = W_5$
f) Engine torque, Nm $= T_e$
g) Overall gear reduction ratio (Lowest gear) $= G_1$
h) Overall gear reduction ratio (Top gear) $= G_2$
j) Tyre rolling radius, m $= r$
k) Total resistance to motion, N $= T_r$
m) Tractive effort at wheels in lowest gear, N $= T_{w1}$
n) Tractive effort at wheels in top gear, N $= T_{w2}$
p) Rolling resistance, N $= R_r$
q) Gradient resistance, N $= R_g$
r) Inertial resistance, N $= R_i$
s) Maximum vehicle speed, m/s $= V$

4 ASSUMPTIONS

For the purpose of ease in calculations, following assumptions have been made:

a) Mechanical efficiency for transmissions = 0.85
b) Rolling resistance = 30 kgf/t = 0.03 percent
c) Maximum gradient available on roads = 1 in 10 (5.7°)
d) Equivalent mass of tractor while accelerating in lowest gear $= 3.0 \times W_3$ kgf
e) Initial acceleration of tractor trailer combination = 0.4 m/s^2
f) Acceleration due to gravity, g = 9.81 m/s^2

5 SELECTION BASED ON TOTAL RESISTANCE TO MOTION

As a worst condition, it is assumed that the tractor-trailer combination is required to overcome all the resistances, that is Rolling resistance, Gradient resistance and Inertial resistance simultaneously. The air resistance is neglected as initial speed of vehicle is zero.

Total resistance $= T_r$

= Rolling resistance + Gradient resistance + Inertial resistance

$$= R_r + R_g + R_i$$

$$= 0.030 \times (W_3 + W_5) \times 9.81 + 0.1 \times (W_3 + W_5) \times 9.81 + (3 \times W_3 + W_5) \times 0.4 \text{ N}$$

$$= 0.294\,3 \times (W_3 + W_5) + 0.981 \times (W_3 + W_5) + 1.2\, W_3 + 0.4\, W_5$$

$$+1.275\,3 \times (W_3 + W_5) + 1.2\, W_3 + 0.4\, W_5$$

$$= 2.475\,3\, W_3 + 1.675\,3\, W_5 \text{ N}$$

$$= 2.47\, W_3 + 1.67\, W_5 \text{ N}$$

Tractive effort at wheels in lowest gear $= \dfrac{T_e \times G_1 \times 0.85}{r} = T_{w1}$ N

The tractor under consideration will qualify for selection if,

$$T_{w1} > T_r$$

that is $\frac{T_e \times G_1 \times 0.85}{r} > 2.47\,W_3 + 1.67\,W_5$

6 SELECTION BASED ON ROAD ADHESION

Maximum traction generated due to road adhesion = GVW of tractor × Acceleration due to gravity × Coefficient of adhesion

$$= W_3 \times 9.81 \times 0.8\ \text{N}$$
$$= 7.848 \times W_3\ \text{N}$$

This should be greater than T_r to achieve mobility (the inspection of the relationships given in **5** and **6**) above reveals that the trailer weight should not exceed the tractor weight by 3 times. This can be taken as a thumb rule that is $3 \times W_3 = W_5$.

7 SELECTION BASED ON PLAIN ROAD APPLICATION IN TOP GEAR

In this condition, the tractor-trailer combination is required to overcome only rolling resistance in top gear, effect of air resistance may be considered, if appreciable. However, the rolling resistance will be around 0.02 per cent on tarmac road and considering air resistance the total resistance may be considered as 0.03 per cent.

$$\text{Tractive effort at wheels in top gear} = \frac{T_e \times G_2 \times 0.85}{r} = T_{w2}\ \text{N}$$

$T_{w2} >$ Rolling resistance

$$\frac{T_e \times G_2 \times 0.85}{r} > 0.03 \times (W_3 + W_5) \times 9.81$$
$$> 0.294\,3\,(W_3 + W_5)$$
$$> 0.3\,(W_3 + W_5)$$

8 SELECTION BASED ON MAXIMUM SPEED ON PLAIN ROAD IN TOP GEAR

P = power of engine, kW

0.85 = transmission efficiency

R_r = rolling resistance, N

V = maximum vehicle speed = 14 m/s say for example (50 km/h)

$$1\,000 \times P \times 0.85 = R_r \times V$$
$$= 0.03 \times (W_3 + W_5) \times 9.81 \times 14$$
$$= 4.120\,2\,(W_3 + W_5)$$

Power of vehicle engine should be:

$$P = \frac{4.120\,2\,(W_3 + W_5)}{0.85 \times 1\,000}$$
$$= 0.004\,847\,(W_3 + W_5)\ \text{kW}$$
$$= 0.005\,(W_3 + W_5)\ \text{kW for 50 km/h}$$
$$\text{or} = 0.002\,5\,(W_3 + W_5)\ \text{kW for 25 km/h}$$

However, this speed should be achievable at wheels considering the engine speed, transmission ratio and rolling radius.

9 SELECTION BASED ON THE COMPATIBILITY FOR THE PRIME MOVER AND THE TRAILER

The compatibility requirements of the tractor and the trailer shall be in accordance with IS 11852 (Part 9).

10 TEST RESULTS

The test results of the verifications done for all the parameters specified in this standard shall be produced in the form of test report.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Transport Tractors, Trailers and Industrial Trucks Sectional Committee, TED 22

Organization	*Representative(s)*
P. L. Haulwel Ltd, Chennai	Shri S. Ramsubramanian (***Chairman***) Shri B. Ramesh (*Alternate*)
Ashok Leyland Ltd, Chennai	Shri P. Dhanasekarn
Automotive Research Association of India, Pune	Shri S. Raju Shri A. Akbar Badusha (*Alternate*)
Bharat Earth Movers Ltd, Bangalore	Shri M. P. Sriram Shri T. Sriram (*Alternate*)
Brakes India Ltd, Chennai	Shri K. N. Balaji Shri K. Kannabiran (*Alternate*)
Central Institute of Road Transport, Pune	Shri V. R. Jalgaonkar Shri D. G. Shirke (*Alternate*)
Controllerate of Quality Assurance Vehicle, Ministry of Defence, Ahmednagar	Shri S. K. Chakraborty
Directorate General of Quality Assurance (DGQE), Ministry of Defence, New Delhi	Col R. Puri Lt Col B. T. Jade (*Alternate*)
Directorate of Standardization, New Delhi	Col G. P. Krishnamurthy
Indian Federation of Transport Operators, Mumbai	Shri Tilak Chand Mangatram Obhan Shri Harkirat Singh Kholi (*Alternate*)
Indian Tyre Technical Advisory Committee, New Delhi	Shri V. Abraham Shri T. Falcao (*Alternate*)
Ministry of Surface Transport (Roads Wing), New Delhi	Shri Nirmal Jit Singh
Ministry of Surface Transport (Development Wing), New Delhi	Shri G. P. Roy Shri T. K. Dutta (*Alternate*)
Tata Motors Ltd, Pune	Shri B. K. Ghosh Shri S. V. Kulkarni (*Alternate*)
Volvo India Ltd, Bangalore	Shri V. Ashok Kumar
Veermata Jeejabai Technological Institute, Mumbai	Dr S. S. Mantha
Vehicle Research Development Establishment, Ahmednagar	Shri P. S. Deshpande Shri K. Kamraj (*Alternate*)
BIS Directorate General	Shri K. K. Vashistha, Director and Head (TED) [Representing Director General (*Ex-officio*)]

Member Secretary
Shri V. Arumugam
Joint Director (TED), BIS

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